1350.01 General

Soil bioengineering is a land stabilization technology applied to disturbed sites and on slope and streambank projects. A multidisciplinary partnership is used to implement soil bioengineering techniques. Project managers initiate and design bioengineering features by employing the expertise of WSDOT hydraulic engineers, geotechnical engineers, engineering geologists, landscape architects, horticulturists, biologists, water quality specialists, environmental planners, and others. Soil bioengineering for slope stabilization provides additional environmental benefits such as habitat enhancement and water quality improvement.

All soil bioengineering proposals should include consideration of slope geometry, climate, water regime, soil properties, and surrounding vegetation. Applications of soil bioengineering are divided into three general categories: erosion control, streambank or shoreline stabilization, and upland slope stabilization. Refer to manuals according to the related discipline.

1350.02 References

For more detailed information, see:

Design Manual chapters, M 21-01, WSDOT:

1300 Roadside Development

510 Investigation of Soils, Rock, and Surfacing Materials

640 Geometric Cross Section

1210 Hydraulics

1130 Retaining Walls

Geotechnical Guidance — see geotechnical report for slope/soil stability. If further assistance is needed, contact Regional Materials Engineer.

Hydraulics Manual, M 23-03, WSDOT — for hydrology criteria.

Highway Runoff Manual, M 31-16, WSDOT — for Stormwater Site Plans, Temporary Erosion and Sediment Control Plans, and best management practices.

Roadside Manual, M 25-30, WSDOT — for vegetation and site preparation criteria, plant selection, design configurations, and other related topics.

Roadside Classification Plan, M 25-31, WSDOT — policy and guidelines for roadside treatment. Contact the region's Landscape Architect Office or the OSC Roadside and Site Development Services Unit at the Olympia Service Center.

Environmental Procedures Manual, M 31-11, WSDOT — permits.

Internet Bioengineering Drawings, WSDOT Homepage (http://www.wsdot.wa.gov/eesc/cae/design/roadside/bioeng.htm)

1350.03 Uses

(1) General

Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems. This technique uses living plants to control and prevent soil erosion, sedimentation, and shallow slope instability. The bioengineered solution benefits from engineering techniques that use live plant material.

Soil bioengineering methods can be cost effective and a useful mitigation solution for site specific problems. Soil bioengineering is effective in erosion control, streambank stabilization, and some upland instabilities. Soil bioengineering, like other engineering techniques, is not

applicable in all situations. Soil bioengineering techniques may not effectively mitigate severe bridge scour, severe roadway erosion conditions, or deep seated slope instabilities. In such cases, soil bioengineering can be used in combination with other engineering techniques.

The use of native vegetation that is adapted to the conditions of the project site will increase the success of the application of soil bioengineering techniques. Over time, native vegetation will encourage the establishment of a diverse plant community and discourage undesirable and invasive plant species.

Other applications of soil bioengineering include:

- Wildlife and fisheries habitat enhancement
- Reinforcement and steepening of cut and fill slopes to limit impacts to adjacent properties and sensitive areas
- Vegetated buffer enhancement on steep slopes
- Enhancement of stormwater treatment areas and stabilization of drainage ways by providing erosion prevention and sediment control
- Site specific mitigations using standard geotechnical solutions in combination with vegetative control

(2) Erosion Prevention

Soil Bioengineering techniques can provide erosion prevention in the top soil layers. Erosion is the detachment and transport of surficial soil particles through the action of water, wind, and ice. Plant shoots and foliage diminish rainfall erosion and remove excess moisture through transpiration. Roots reinforce the soil mantle, allowing the system to grow more stable with age. Vegetative material slows down runoff and traps soil thereby reversing the effects of erosion. Refer to the *Roadside Manual* for more information.

(3) Streambank Stabilization

Soil bioengineering techniques can be used to stabilize streambanks, enhance wildlife habitat, improve water quality by controlling sediments, and protect structures. Bioengineering in the riparian zone (banks of streams, wetlands, lakes, or tidewater) requires an hydraulic study of stream characteristics and changes in stream alignment. Refer to the *Hydraulics Manual* for more information.

(4) Upland Slope Stabilization (generally less than one meter in depth)

Upland slope stabilization refers to the use of vegetation and plant materials to reduce or prevent soil erosion caused by wind or water on slopes not directly adjacent to riparian zones.

There are three classifications of unstable slopes:

- **Surface movement** refers to surface erosion caused by wind or water on slopes
- **Shallow-seated instability** is defined as a failure surface less than one meter in depth
- **Deep-seated instability** is defined as a failure surface greater than one meter in depth

Soil bioengineering is used for slopes that are at risk of shallow landslides, slumps, sloughing, and surface erosion. Soil bioengineering techniques are most applicable to shallow slope stabilization projects characterized by unstable slopes that have surface movement. Surface movement of soils can be induced by soil creep, repeated freeze-thaw cycles, and soil erosion. The processes that influence overall slope stability, such as heavy and prolonged erosion and continuous slow soil movement, can significantly alter slope geometry.

Soil bioengineering alone is not appropriate for deep-seated landslides, but can be used in conjunction with other engineering methods to treat associated shallow instabilities.

Soil bioengineering techniques can be used to stabilize the slopes of construction sites or to repair disturbed or damaged slopes. Soil bioengineering is applied to both cut and fill slopes.

Factors	Parameters	Design Considerations/Specifications
Climate/ Microclimate	Growing season Exposure/Aspect	Select suitable plants, methods and construction timing
Soil, Physical	Density and rootability Permeability	Modify during construction Select suitable plants
Soil, Water	Profile available water	Modify soil during construction Install structures (drains, ditches etc.) to remove excess water
Soil, Chemical	pH Fertility Cation Exchange	Select suitable plants Add lime, fertilizers Ameliorate soil
Erosion Risk	Soil erodibility Rainfall erosivity Channel discharge Slope Wind, Water, Ice	Temporary or Permanent covers Select suitable plants Management Reinforcement with geotextile
Geotechnical	Shear strength Slope Factor of Safety	Select suitable soil materials Structures Soil density and moisture Reinforcement with geosynthetics (Chapter 530)

(5) Strategies

When planning for site specific soil bioengineering design, consider the factors, parameters, and design considerations/ specifications in the following table.

1350.04 Design Responsibilities and Considerations

Consider the possible applications for soil bioengineering during the project definition process. Address soil bioengineering applications during the design process as part of the recommendations in the Hydraulic Report (for streambank/shoreline), Stormwater Site Plan (SSP), Geotechnical Report (for slope stabilization), and in the Environmental Documents. These reports provide design criteria and guidelines.

1350.05 Documentation

For all applications, include in the documentation a summary of site analysis, a list of design options considered along with a summary of evaluations, and management plans. The following is a list of soil bioengineering applications and the documents that support the designs.

(1) Erosion Control

- ☐ Temporary Erosion and Sediment Control Plan (TESC), *Highway Runoff Manual*
- ☐ Stormwater Site Plan (SSP), *Highway Runoff Manual*
- ☐ Roadside Restoration Plan including the Horticultural Report, OSC Horticulturalist and the region's Landscape Architect Office or the OSC Roadside and Site Development Unit

(2) Streambank/Shoreline Stabilization

- ☐ Hydraulics Report, *Hydraulics Manual*
- ☐ Roadside Restoration Plan, region's Landscape Architecture Office or the OSC Roadside and Site Development Unit

(3) Upland Slope Stabilization

- ☐ Geotechnical Report, *Design Manual*
- ☐ Geotechnical Report, Geotechnical Branch
- ☐ Roadside Restoration Plan, region's Landscape Architecture Office or the OSC Roadside and Site Development Unit

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